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[54] **IMAGE FORMING APPARATUS HAVING A DEVICE TO APPLY A RELEASE AGENT TO A SURFACE OF A TRANSFER ROLLER**

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[51] **Int. Cl.**[6] **G03G 15/16**
[52] **U.S. Cl.** **399/98**; 399/101; 399/313
[58] **Field of Search** 399/98, 101, 297, 399/313

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,442,428	8/1995	Takahashi et al. .	
5,461,461	10/1995	Harasawa et al. .	
5,469,247	11/1995	Cheng et al.	399/350
5,510,886	4/1996	Sugimoto et al.	399/308
5,666,622	9/1997	Harasawa et al. .	
5,701,566	12/1997	Bisaiji et al. .	

FOREIGN PATENT DOCUMENTS

6-337598	12/1994	Japan .
6-342234	12/1994	Japan .
7-239616	9/1995	Japan .
7-271142	10/1995	Japan .
7-271262	10/1995	Japan .

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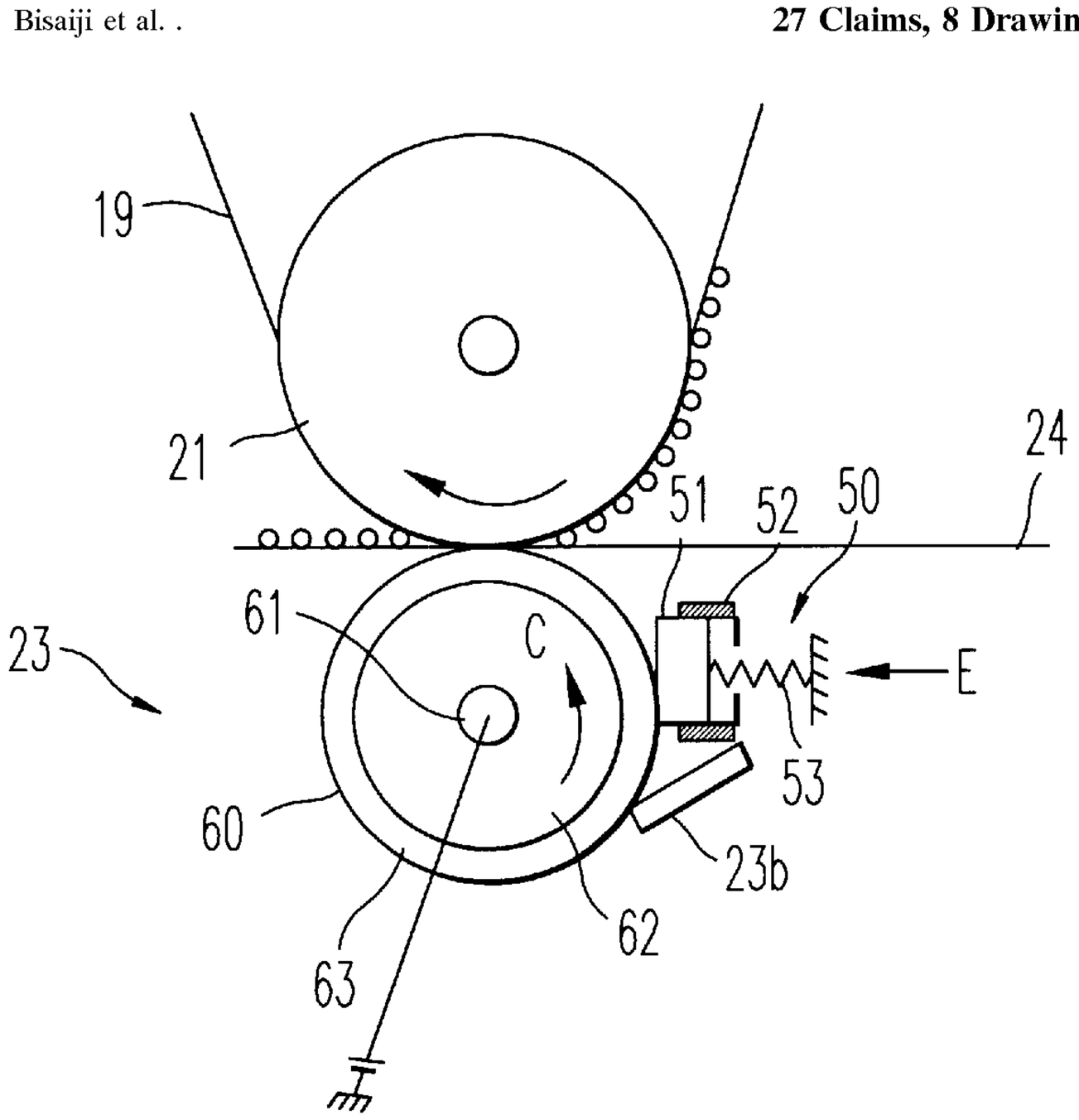
Attorney, Agent, or Firm—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

[57] **ABSTRACT**

An image forming apparatus includes a transfer device to transfer an image on an image carrier to a transfer sheet. The transfer device includes a transfer roller and transfers an image on the image carrier to a transfer sheet conveyed into a transfer area between the transfer roller and the image carrier by applying a bias voltage to the transfer roller. The transfer device includes a device to apply a release agent for an alien substance to a surface of the transfer roller. Toner and an alien substance, such as paper dust, thereby hardly adheres to the release agent applied on the surface of the transfer roller. Even if toner and/or an alien substance are put on the release agent applied on the surface of the transfer roller, such toner and/or an alien substance are easily removed by a cleaning device. Thus, lowering of an image quality due to insufficient cleaning of the transfer roller is avoided.

27 Claims, 8 Drawing Sheets



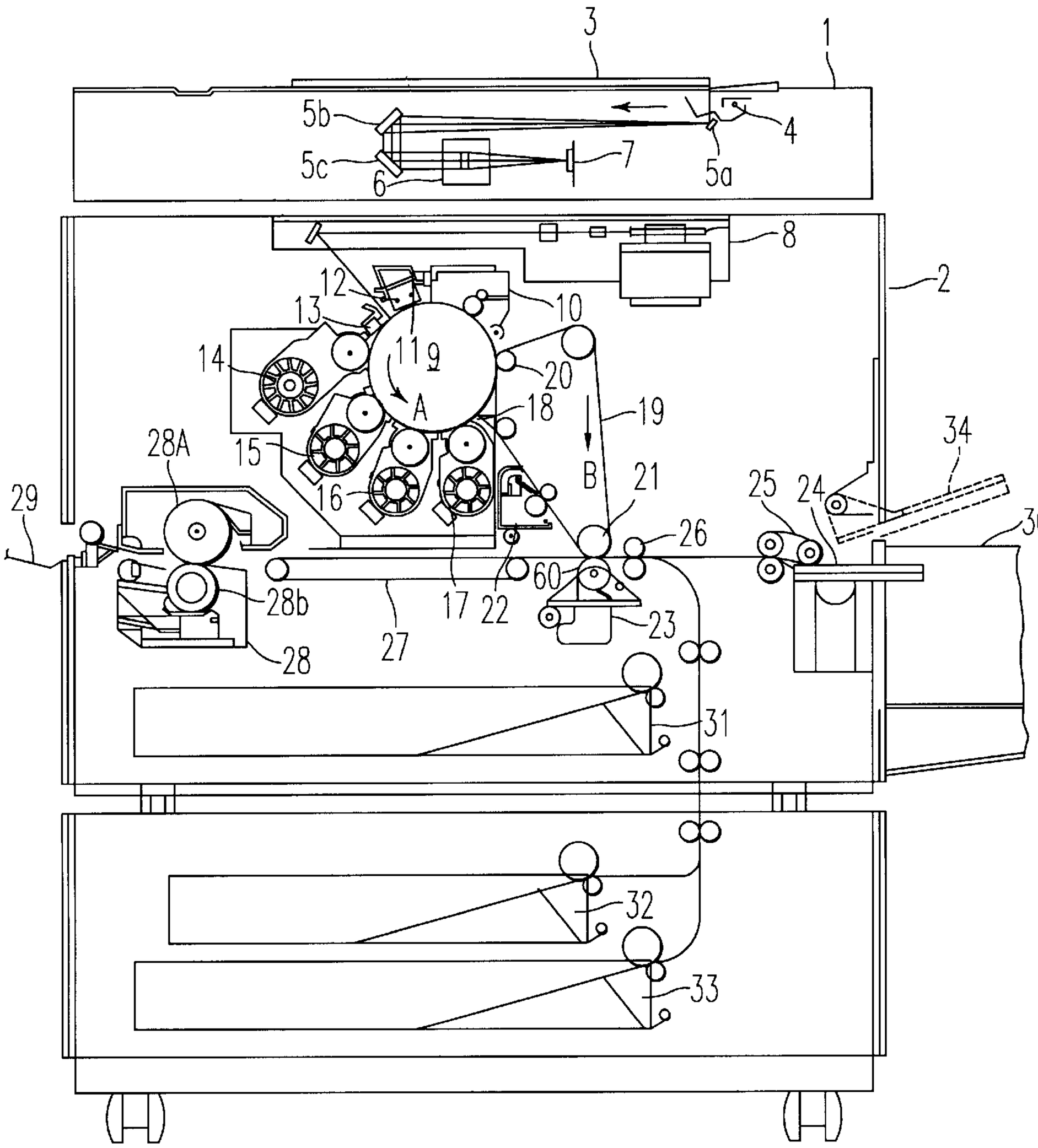
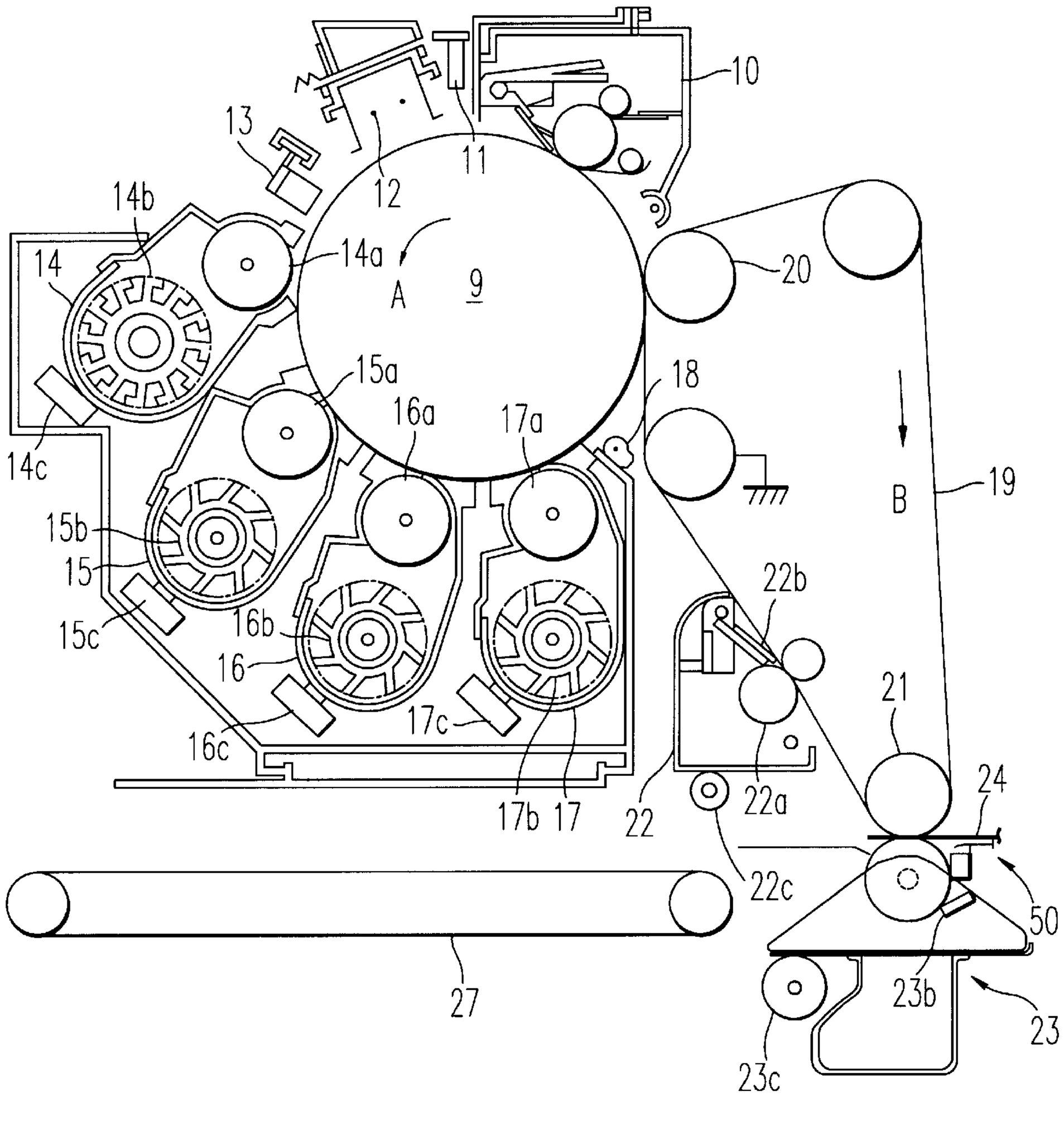

3
1
5b
5c
6
7
4
5a
8
2
12
13
14
11
9
10
20
A
18
19
B
21
15
16
17
22
28A
29
28b
28
27
60
23
25
24
34
26
30
31
32
33

FIG. 1


10
11
12
13
14
14a
14b
14c
15
15a
15b
15c
16
16a
16b
16c
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17a
17b
17c
18
19
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22b
22c
23
23b
23c
24
50
27
A
9
B

FIG. 2

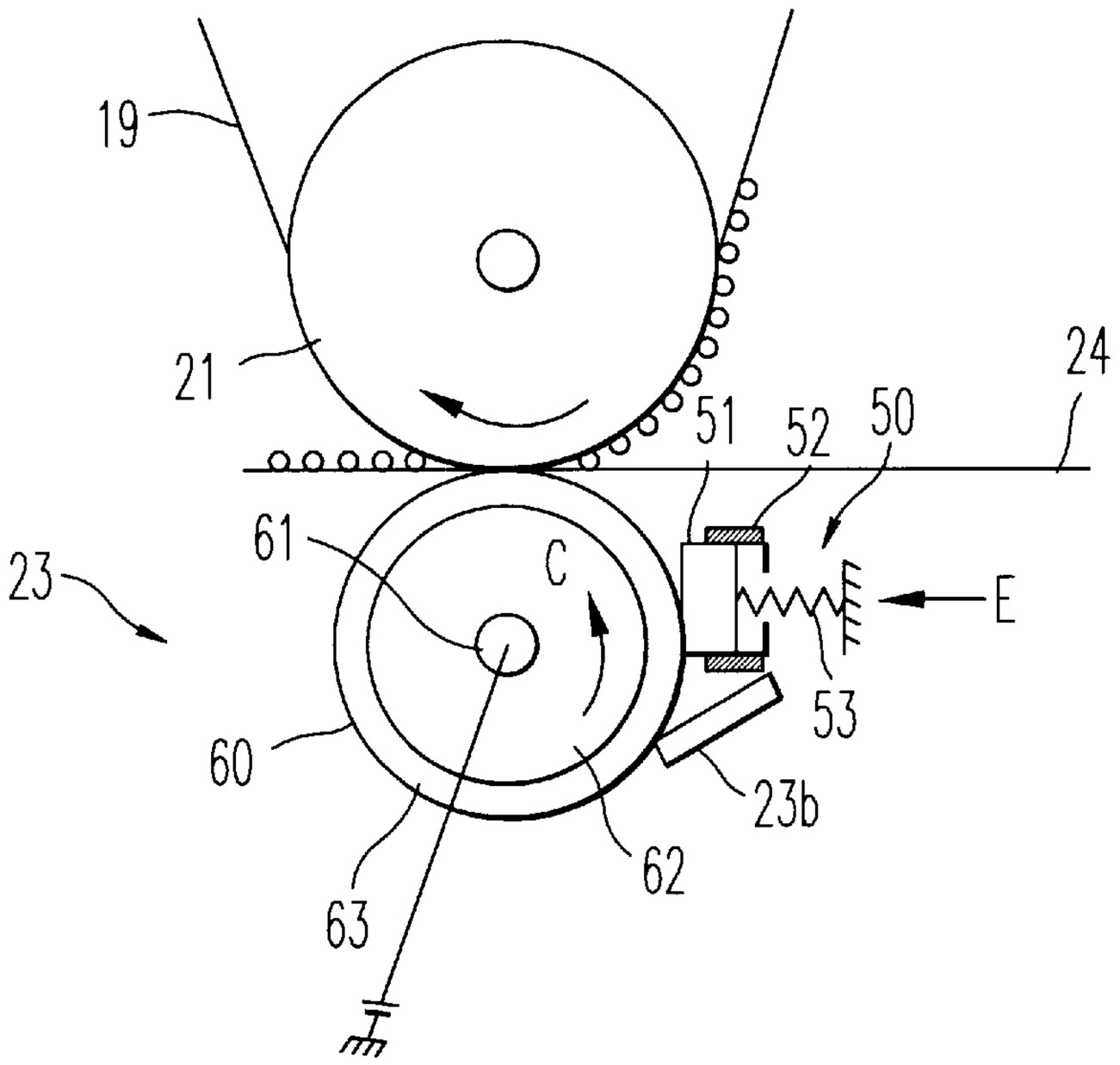

FIG. 3

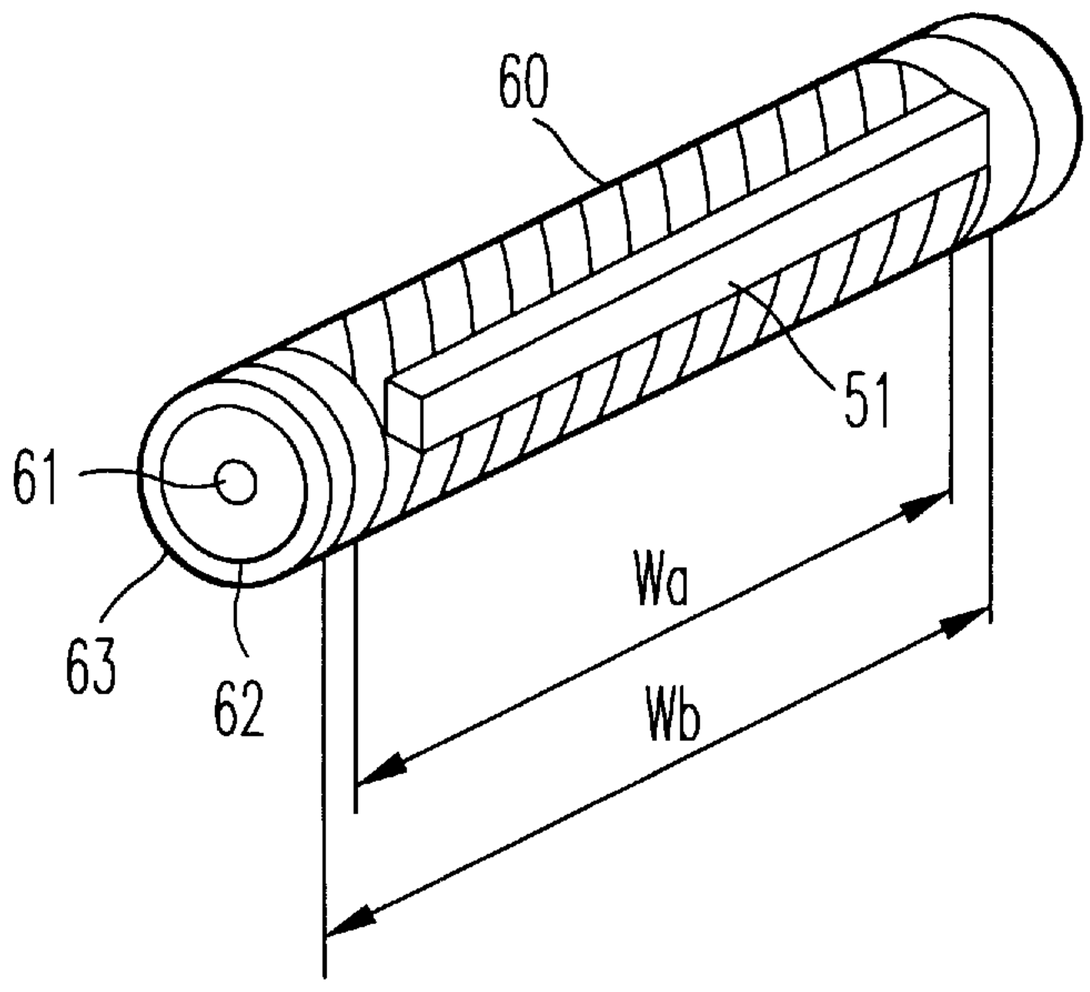

FIG. 4

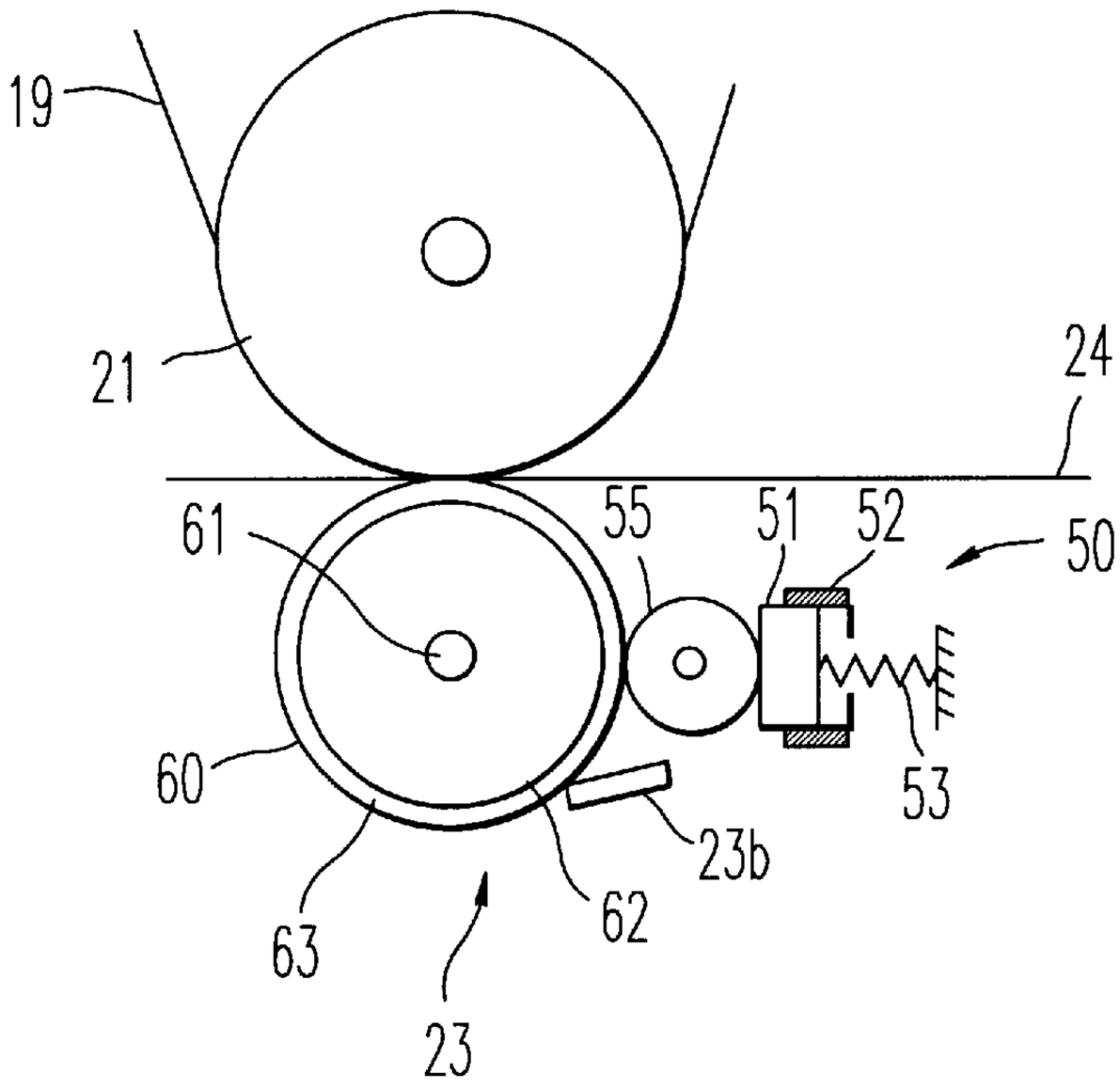
19
21
24
61
55
51
52
50
60
53
23b
63
62
23

FIG. 5

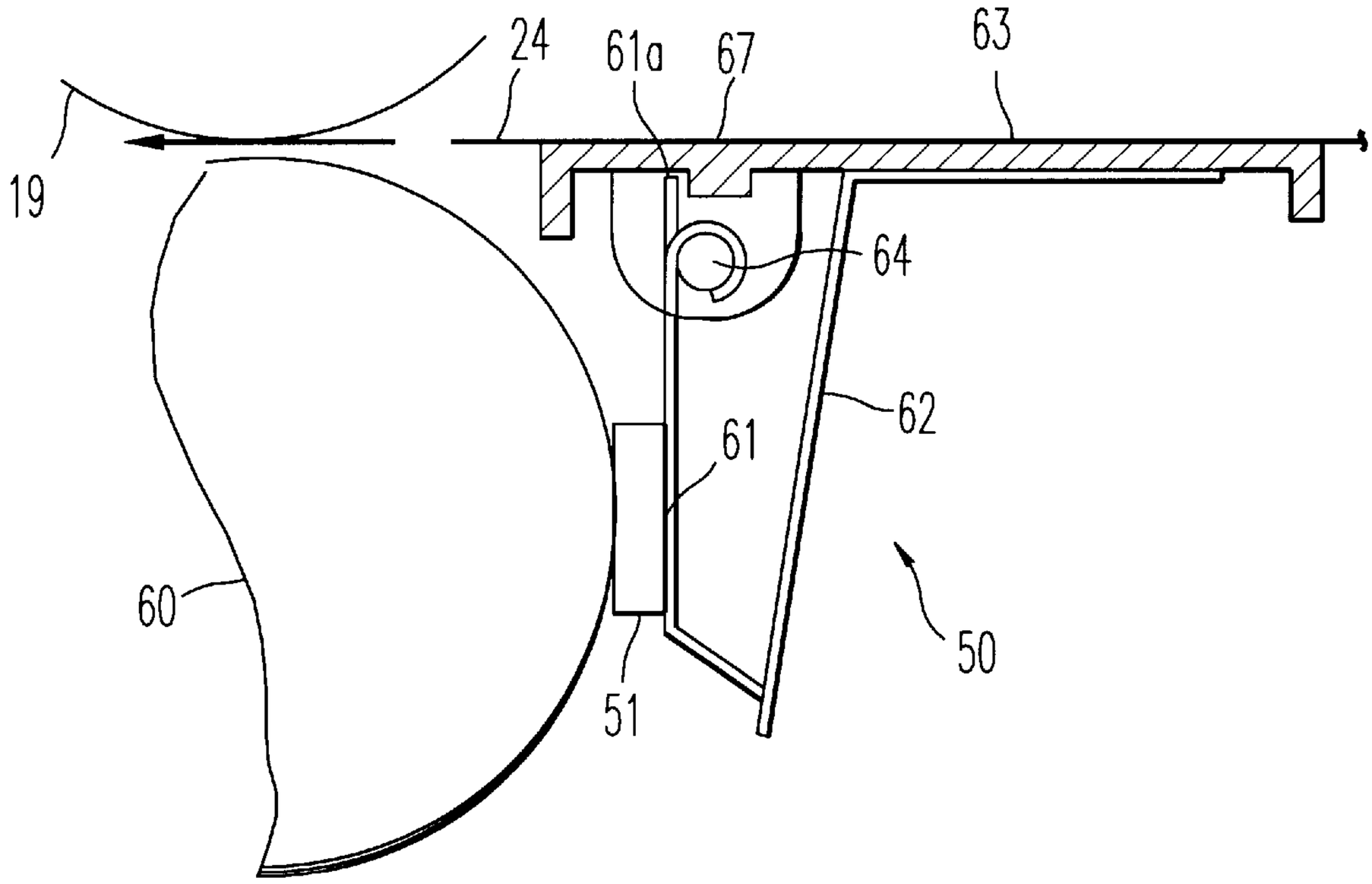
24
61a
67
63
19
64
62
61
60
51
50

FIG. 6

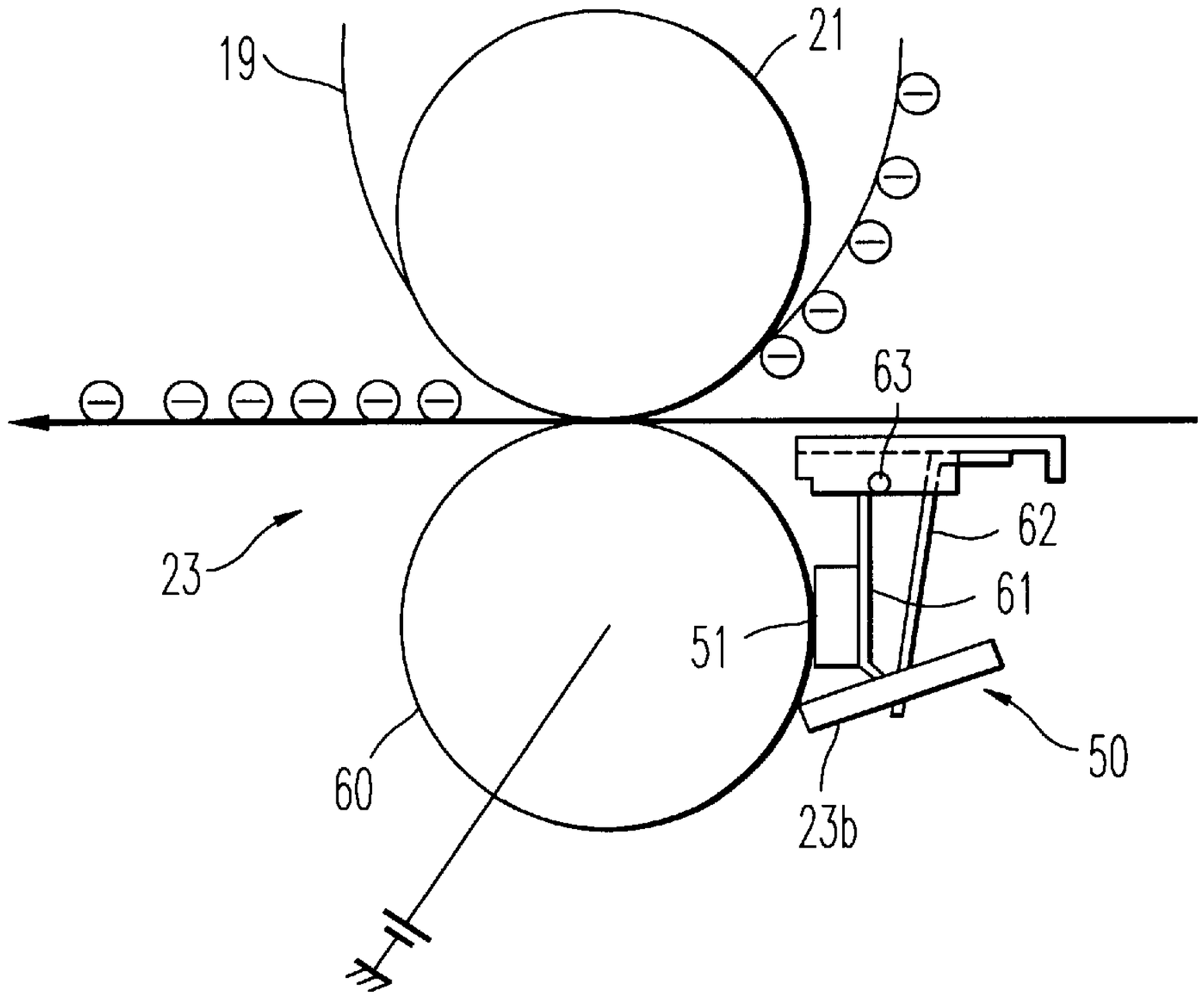

FIG. 7

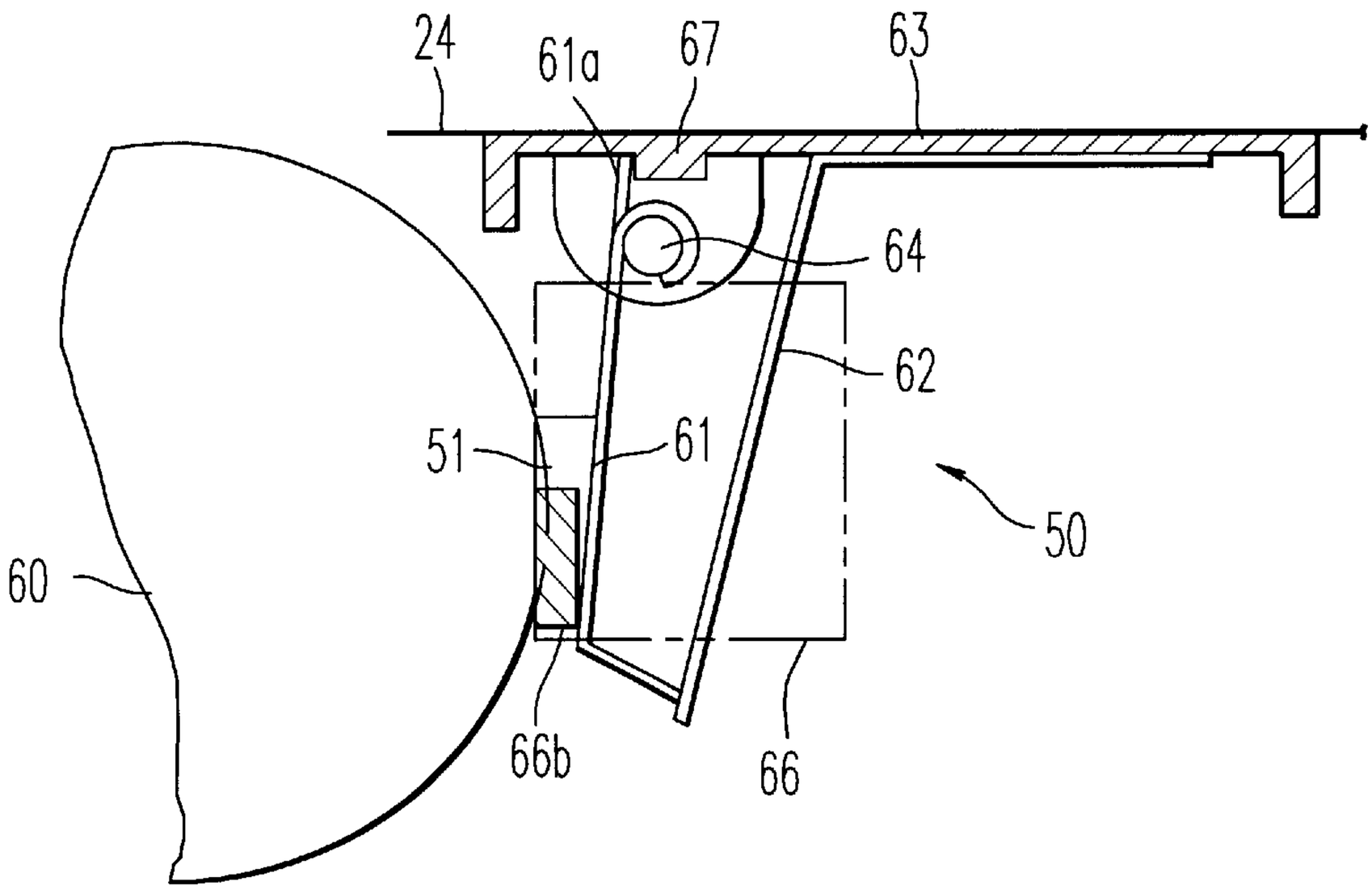

FIG. 10

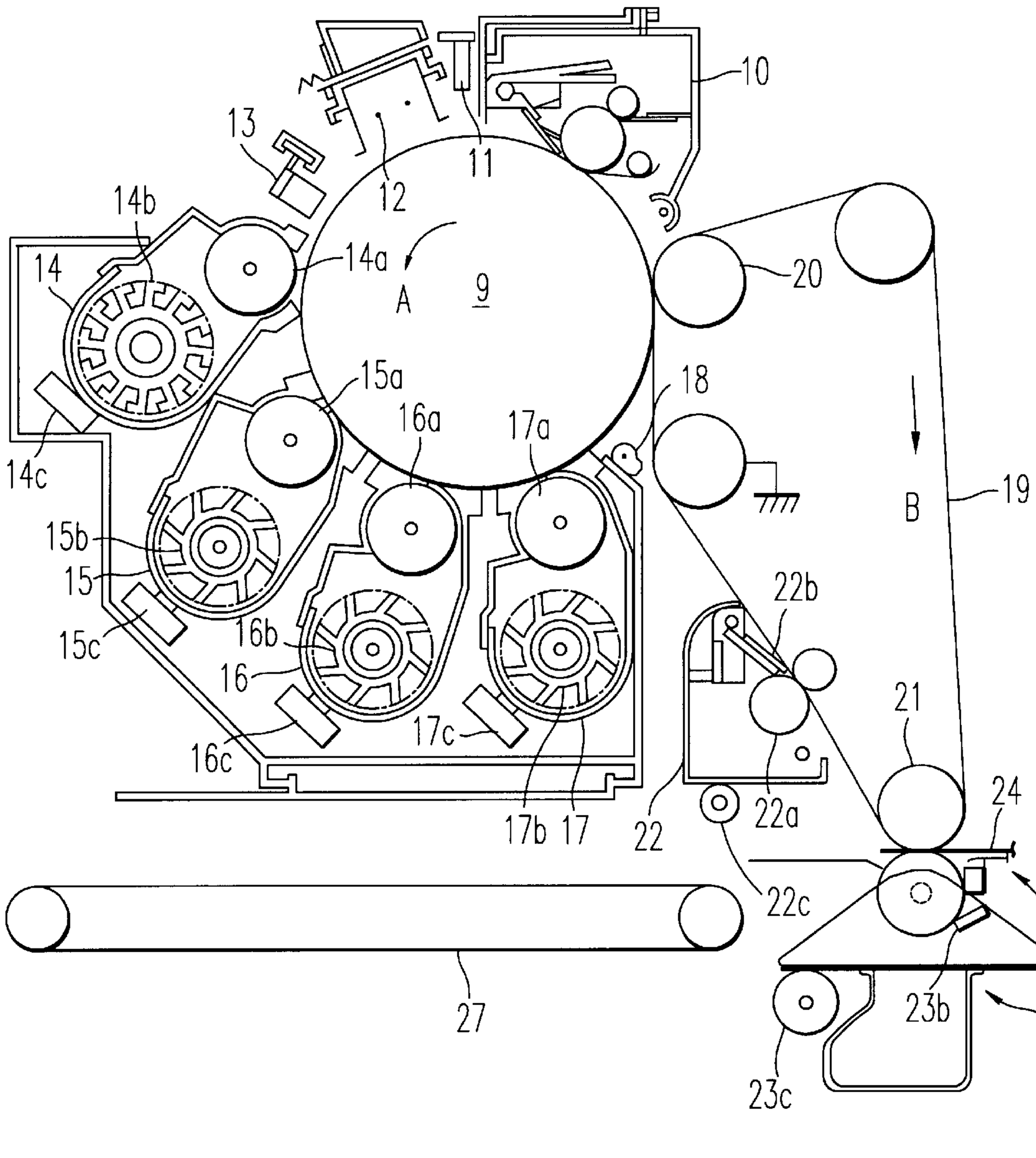
10
13
11
12
14b
14a
14
A
9
20
15a
18
16a
17a
14c
15b
15
B
19
22b
15c
16b
16
21
16c
17c
17b
17
22
22a
24
22c
50
27
23b
23
23c

FIG. 8

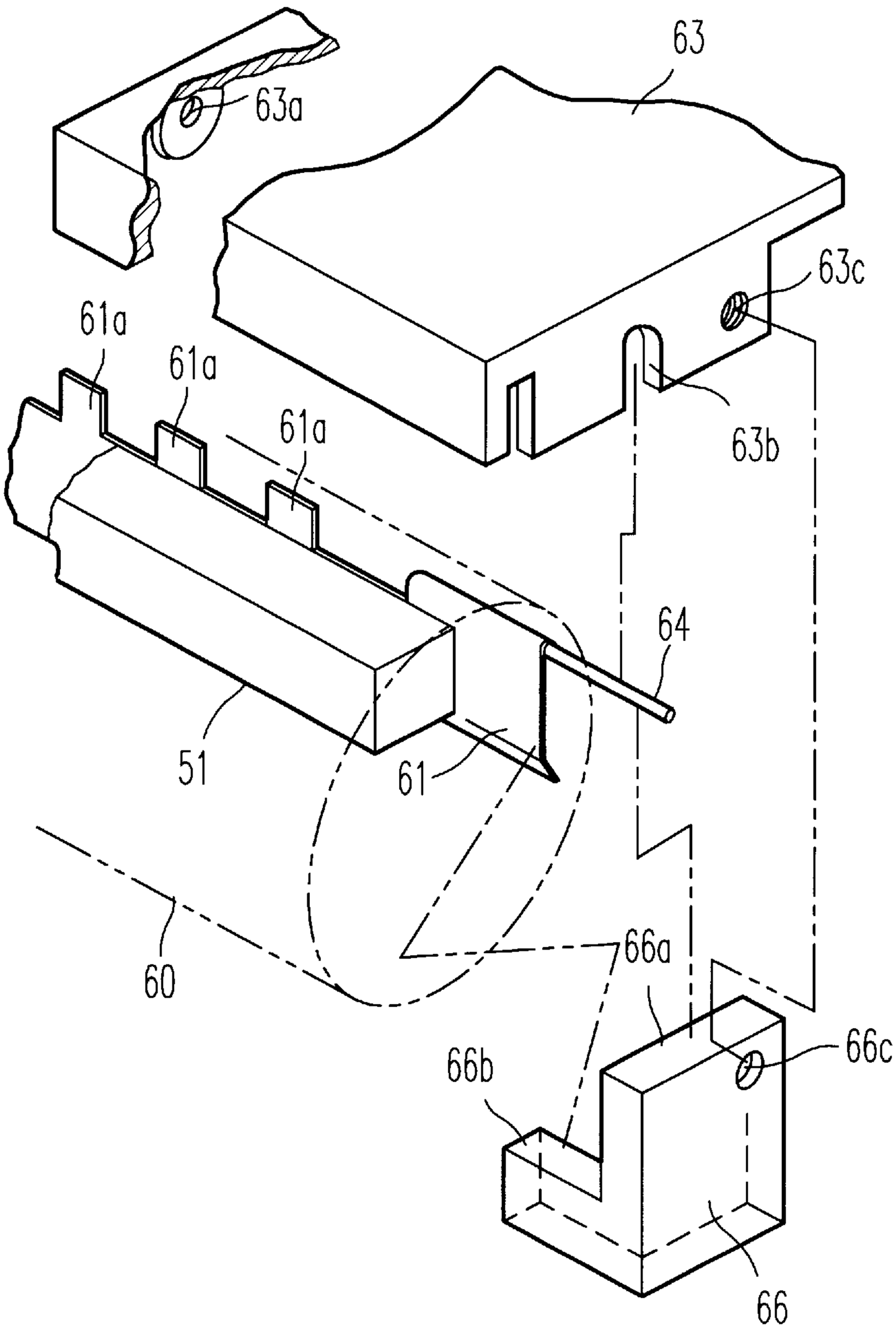

FIG. 9

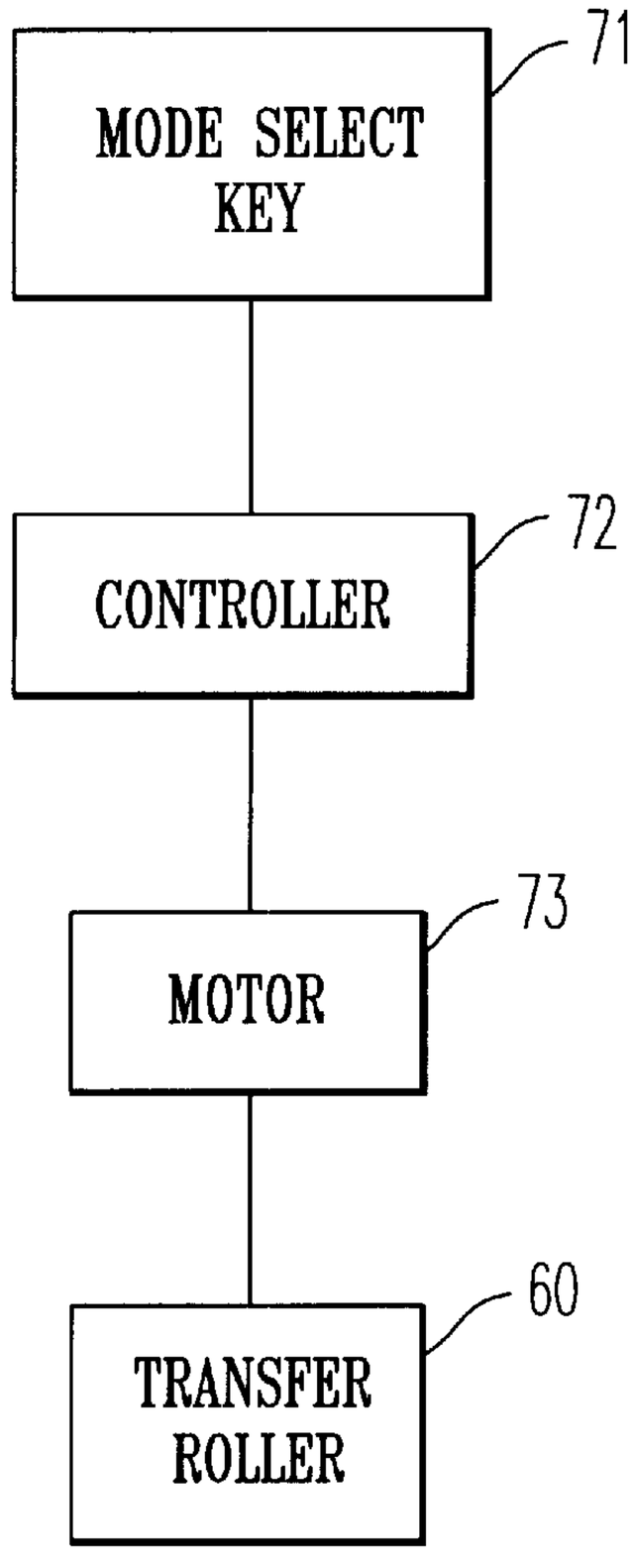
MODE SELECT KEY
71
CONTROLLER
72
MOTOR
73
TRANSFER ROLLER
60

FIG. 11

IMAGE FORMING APPARATUS HAVING A DEVICE TO APPLY A RELEASE AGENT TO A SURFACE OF A TRANSFER ROLLER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image forming apparatus, such as a copying machine, a printer, a facsimile machine, etc., and more particularly relates to an image forming apparatus including an image transfer device having a transfer roller.

2. Discussion of the Background

In an image forming apparatus utilizing electrophotography, such as a copying machine, a printer, a facsimile machine, etc., an image transfer device is provided to transfer a toner image formed on an image carrier of the apparatus to a transfer sheet conveyed to a transfer position between the image carrier and the transfer device.

An example of an image transfer device includes a charger to apply a corona charge to a transfer sheet when transferring an image on the image carrier to the transfer sheet. Another example of an image transfer device includes a transfer roller which transfers an image formed on an image carrier to a transfer sheet by applying a voltage to the transfer roller when the transfer sheet passes through a transfer position between the transfer roller and the image carrier.

In such a transfer device including a transfer roller, since a surface of the transfer roller contacts a surface of the image carrier via a transfer sheet, toner on the surface of the image carrier is hardly transferred to the surface of the transfer roller. However, when multiple images are formed in succession on the image carrier, such as when making multiple copies, since a gap exists between the images, toner adhering to a part of the image carrier corresponding to the gap is transferred to the surface of the transfer roller. Further, when a transfer sheet to be conveyed to the transfer position jams and is not conveyed to the transfer position, a toner image formed on the surface of the image carrier directly contacts the surface of the transfer roller, and as a result the toner is put on the surface of the transfer roller.

If a next toner image is then formed to be transferred to a next transfer sheet, when the next transfer sheet passes the transfer position for the transfer, such toner put on the surface of the transfer roller is transferred to a back surface of the next transfer sheet. When a duplex copy is made, after an image is transferred to a first surface of a transfer sheet, the transfer sheet carrying the transferred image on the first surface is returned so that another toner image is transferred to the back surface. Therefore, if the back surface of the transfer sheet is stained by toner remaining on the surface of the transfer roller when transferring the image to the first surface of the transfer sheet, the image transferred to the back surface next is disturbed by such toner transferred from the transfer roller. Further, since the first surface of the transfer sheet on which the image is first transferred contacts the transfer roller, the image on the first surface is also damaged by the toner remaining on the transfer roller if any toner remains on the transfer roller.

Therefore, in background image forming apparatuses, a cleaning device is provided to scrape off toner adhering to a surface of a transfer roller, such as, for example, a cleaning blade made of rubber or the like. Toner is scraped off the transfer roller by bringing an edge of the cleaning blade in contact with the surface of the transfer roller which is rotating.

Further, a mechanism is provided to separate the cleaning blade from the transfer roller when cleaning is not performed, for preventing damage to the surface of the transfer roller.

Further, in order to achieve optimum cleaning performance of the cleaning blade, a control mechanism is provided to control a pressing force to press the cleaning blade against the surface of the transfer roller.

However, even when such a cleaning device is provided for cleaning the surface of the transfer roller, a surface of the transfer roller is not cleaned sufficiently when an amount of toner adhering to the surface of the transfer roller is large. For example, when an image is formed in a full color, an amount of toner applied to the image for development is large compared to a case in which the image is formed in a mono-color, and consequently toner adhering to the surface of the transfer roller increases. Therefore, the toner adhering to the surface of the transfer roller is not completely removed by the cleaning device.

Further, when a certain type of transfer sheet is used, a problem occurs that paper dust of the transfer sheet adheres to the surface of the transfer roller. When the transfer device uses a transfer roller, since the transfer sheet is pressed by the transfer roller to the image carrier and is rubbed by the transfer roller, the transfer sheet produces paper dust. Therefore, when the transfer sheet contains a relatively large amount of calcium carbonate, for example, the paper dust coming off the transfer sheet contains calcium carbonate. Such paper dust containing calcium carbonate adheres to the surface of the transfer roller, forming a film thereupon. Such a film can not be easily scraped off by the cleaning device even when the pressing force pressing the cleaning device against the transfer roller is optimized. If the film remains on the surface of the transfer roller and toner is put on the film, the toner adheres to the film and can not be easily removed from the film.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above-discussed problems and to address and resolve these problems.

Accordingly, an object of the present invention is to provide a novel image forming apparatus with a simple structure, in which toner and an alien substance, such as paper dust or the like, hardly adheres to a surface of a transfer roller and, even when toner and an alien substance are put on the surface of the transfer roller, the toner and the alien substance are easily removed, such that lowering of image quality due to insufficient cleaning of the transfer roller is avoided.

In order to achieve the above-mentioned objects, a novel image forming apparatus according to the present invention includes a transfer device to transfer an image on an image carrier to a transfer sheet. The transfer device includes a transfer roller and transfers an image on the image carrier to a transfer sheet conveyed to a transfer position between the transfer roller and the image carrier by applying a bias voltage to the transfer roller. The transfer device includes a release agent applying device to apply a release agent for an alien substance to a surface of the transfer roller. Since toner and an alien substance, such as paper dust or the like, hardly adhere to the release agent applied to the surface of the transfer roller, lowering of image quality due to insufficient cleaning of the transfer roller is prevented.

As the release agent, zinc stearate may be used, because zinc stearate is easily coated to form a layer on a surface of

the transfer roller. Toner and an alien substance hardly adheres to a surface of the zinc stearate layer. Further, even when toner and an alien substance adhere to a surface of the zinc stearate layer, such a toner and an alien substance can be easily removed.

The transfer device may further include a cleaning member to clean a surface of the transfer roller by bringing the cleaning member into contact with the surface of the transfer roller. A width to which the release agent is applied by the release agent applying device may be made narrower than a width the cleaning member cleans, such that a whole surface of the release agent layer is cleaned by the cleaning blade. Thus, toner and paper dust adhering to the surface of the release agent layer can be completely removed.

Further, the release agent applying device may apply the release agent to the surface of the transfer roller at all times when the transfer roller is rotating, such that paper dust coming off the transfer sheet is prevented from accumulating on the surface of the transfer roller.

The release agent may be solidified and the release agent applying device may be configured such that the solid release agent directly contacts the surface of the transfer roller. With such a configuration using a solid release agent, the number of parts of the release agent applying device is reduced and the structure is made simple, and as a result, a cost of the apparatus is reduced.

The transfer device may include an elastic intermediate agent applying member between the transfer roller and the release agent applying device, so that the release agent is applied to a surface of the transfer roller via the intermediate agent applying member. By having such an elastic intermediate agent applying member, a surface of the transfer roller is prevented from being damaged by the release agent directly contacting a surface of the transfer roller.

Furthermore, the transfer device may include a guide member to guide a transfer sheet to a transfer area between the transfer roller and the image carrier, and the release agent applying dcvice may be configured to include a bracket to hold the release agent along a longitudinal surface of the transfer roller. The bracket may be rotatably supported by the guide member and a pressing member presses the bracket, so that the release agent contacts the longitudinal surface of the transfer roller. When the transfer roller rotates, the release agent is applied to the surface of the transfer roller. The release agent applying device may be constructed in an integrated assembly, such that the release agent is integrally supported by the bracket and the bracket is integrally and rotatably supported by the guide member, and such that the release agent applying device is easily mounted to the transfer device at a predetermined position.

For pressing the bracket, a plurality of pressing members may be provided, being equally spaced from each other along the longitudinal surface of the transfer roller. Each of the plurality of pressing members presses the bracket with an equal pressing force, such that the release agent contacts the surface of the transfer roller at a substantially uniform pressing force along the longitudinal direction of the transfer roller even when the surface of the bracket supporting the release agent is not uniformly flat. Thus, the release agent is uniformly applied to the longitudinal surface of the transfer roller.

Still furthermore, the image forming apparatus of the present invention may be provided with a control device to rotate only the transfer roller while stopping an image forming operation including feeding of a transfer sheet. The apparatus may also be provided with a select device to select such a mode to rotate only the transfer roller while stopping the image forming operation. When the transfer roller or the release agent is replaced, by selecting such a mode via the select device, the release agent can be applied on the surface of the transfer roller until forming a same uniform layer of the release agent as before the replacement without continuously forming images and thereby without wasting a large number of transfer sheets.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the present invention and many of the attendants advantages thereof will be readily obtained as the same becomes better understood by reference to following detailed description when considered in conjunction with the accompanying drawings, wherein:

FIG. **1** is a schematic drawing illustrating an overall structure of a full color copying machine as an example of an image forming apparatus of the present invention;

FIG. **2** is an enlarged view of an image forming part of the color copying machine shown in FIG. **1**;

FIG. **3** is a schematic drawing from a front illustrating a structure of a transfer device including a release agent applying device, which is included in the color copying machine shown in FIG. **1**;

FIG. **4** is a perspective drawing illustrating a transfer roller of the transfer device shown in FIG. **3**, with a release agent contacting a surface of the transfer roller;

FIG. **5** is a schematic drawing illustrating a structure of another transfer device including an intermediate agent applying device from the front;

FIG. **6** is a schematic drawing illustrating a structure of another transfer device including another release agent applying device;

FIG. **7** is a schematic drawing illustrating the transfer device shown in FIG. **6**, with an intermediate transfer belt;

FIG. **8** is a schematic drawing illustrating an image forming part of an image forming apparatus including the transfer device shown in FIG. **6**;

FIG. **9** is a perspective exploded drawing illustrating a structure of the release agent applying device shown in FIG. **6**;

FIG. **10** is a schematic drawing for explaining a regulating device to regulate movement of a bracket of the release agent applying device not to contact a surface of the transfer roller; and

FIG. **11** is a block diagram for explaining that the transfer device is controlled through an operation of a mode select key to rotate only the transfer roller while stopping an image forming operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, embodiments of the present invention are now explained.

FIG. **1** is a schematic drawing illustrating an overall structure of a full color copying machine as an example of an image forming apparatus of the present invention, FIG. **2** is an enlarged view of an image forming part of the color copying machine shown in FIG. **1** and FIG. **3** is a schematic drawing from the front illustrating a structure of a transfer device included in the color copying machine shown in FIG. **1**.

As shown in FIG. **1**, the color copying machine as an image forming apparatus includes a color scanner **1** on top of a color printer **2**.

The color printer **2** includes a photoconductive drum **9** as an image carrier to form a latent image thereupon. Arranged around the photoconductive drum **9** are a black color developing unit **14**, a cyan color developing unit **15**, a magenta color developing unit **16** and a yellow color developing unit **17** to develop a latent image formed on the photoconductive drum **9** to a toner image of a corresponding color respectively. The color printer **2** further includes an intermediate transfer belt **19** to which toner images are transferred from the photoconductive drum **9**. The photoconductive drum **9** carries a toner image to a transfer position to transfer the toner image to the intermediate transfer belt **19** by rotating thereof.

The intermediate transfer belt **19** carries the transferred toner image to a position to transfer the toner image to a transfer sheet **24**, where a transfer unit **23** as a transfer device for transferring an image to the transfer sheet **24** is arranged. Further, a conveying belt **27** is provided to convey the transfer sheet **24** carrying the toner image thereupon to a fixing unit **28** where the toner image carried on the transfer sheet **24** is fixed to the transfer sheet **24**.

The color scanner **1** includes a lamp **4** to light an original document **3** to be imaged. The light reflected from a surface of the original document **3** is imaged to a color sensor **7** via mirrors **5***a*, **5***b*, **5***c* and a lens **6**. The color sensor **7** includes a color separating device to separate colors of light to black, green and red, and an optic-to-electric converter, such as, for example, a charge-coupled device, to convert light to an electric signal. The color sensor **7** reads color image data for the original document by separating the colors of the imaged light to black, green and red. The line sensor **7** in this example reads color image data for three colors at one time in one operation.

Then, an image processor (not shown) performs color conversion in accordance with a signal level of each signal for black, green and red to generate color image data for black, cyan, magenta and yellow respectively.

The color printer **2** further includes a laser writing unit **8**, which irradiates laser light corresponding to the image data for each color on a surface of the photoconductive drum **9** to form a corresponding latent image thereupon.

Each of the latent images for black, cyan, magenta and yellow is respectively developed in sequence by corresponding color toner in the developing units **14**, **15**, **16**, **17** to form a toner image, which toner images are then transferred to the intermediate transfer belt **19** one by one. Each toner image is superimposed with others when transferred to the intermediate transfer belt **19** to form a full color image on the intermediate transfer belt **19**.

The color scanner **1** reads the original document **3** by moving the lamp **4** towards the left in FIG. **1** synchronized with a movement of the color printer **2**. Since the color copying machine shown in FIG. **1** does not include a memory to store image data, reading of an original document is performed four times to obtain color image data for four colors.

Around the photoconductive drum **9**, besides the developing units **14**, **15**, **16**, **17** for each color and the intermediate transfer belt **19**, there are arranged a cleaning unit **10** to clean a surface of the photoconductive drum **9**, a discharge lamp **11** to discharge a surface of the photoconductive drum **9**, a charger **12** to charge a surface of the photoconductive drum **9**, a charge sensor **13** to sense a charge level on the photoconductive drum **9** and a developing density detector **18** to detect a density of a toner image formed on the photoconductive drum **9**.

As shown in FIG. **2**, the developing units **14**, **15**, **16**, **17** respectively include developing rollers **14***a*, **15***a*, **16***a*, **17***a*, which rotate so that developer sleeves or ears formed on the surfaces of the developing rollers **14***a*, **15***a*, **16***a*, **17***a* contact a surface of the photoconductive drum **9** to develop a latent image on the photoconductive drum **9**. The developing units **14**, **15**, **16**, **17** further include respective developer paddles **14***b*, **15***b*, **16***b*, **17***b* to scoop up and agitate the developer and toner density sensors **14***c*, **15***c*, **16***c*, **17***c* to detect density of toner in the developing units **14**, **15**, **16**, **17**. In this embodiment, reading of an original document for each color and development of an image for each color are performed in the order of black, cyan, magenta and yellow.

When an operation of forming a color image is started with the above-described color copying machine, the photoconductive drum **9** rotates in a direction indicated by an arrow in FIGS. **1** and **2** and the charger **12** uniformly charges the surface of the photoconductive drum **9**. After image data for a plurality of colors corresponding to the color image of the original document **3**, which is sent from the color scanner **1**, is processed by an image processor (not shown), the laser writing unit **8** irradiates laser light corresponding to the color image data, black image data in this case, onto the charged surface of the photoconductive drum **9** to form a corresponding black latent image thereupon.

The black developing roller **14***a* of the black developing unit **14** is rotated so as to form developer sleeves or ears therefrom before a leading edge of the latent image for black formed on the surface of the photoconductive drum **9** reaches the developing position of the black developing unit **14**, so that the latent image for black is developed to a black toner image by the black developing unit **14**.

When a trailing edge of the black latent image passes the developing position of the black developing unit **14**, the formation of developer sleeves or ears on the black developing roller **14***a* is immediately stopped to disable the development by the black developing unit **14**. Such a stoppage of the formation of developer sleeves or ears is made by changing a rotation of the black developing roller **14***a* in an opposite direction and has to be completed before a leading edge of the cyan latent image according to cyan image data of the original document reaches the developing position of the black developing unit **14**.

The black toner image thus formed on the surface of the photoconductive drum **9** is then transferred to a surface of the intermediate transfer belt **19** which is rotating in an adjacent position at a same rotating speed as the photoconductive drum **9**. The image is transferred from the photoconductive drum **9** to the intermediate transfer belt **19** by applying a predetermined bias voltage to an intermediate transfer bias roller **20** which is arranged in a transfer position contacting the photoconductive drum **9** via the intermediate transfer belt **19**. The bias voltage is applied with a bias electric source (not shown) when a part of the photoconductive drum **9** carrying the toner image is in contact with the intermediate transfer belt **19**.

After transfer of the image, residual toner on the photoconductive drum **9** is removed by the cleaning unit **10** and then the photoconductive drum **9** is discharged by the discharge lamp **11**, so that a next image forming operation can be started.

Following completion of the transfer of the black toner image to the intermediate transfer belt **19**, the color scanner

1 reads a cyan image at a predetermined timing, and then laser writing in accordance with the cyan image data is performed to form the cyan latent image on a surface of the photoconductive drum **9**.

The cyan developing unit **15** starts rotating the cyan developing roller **15***a* to form developer sleeves or ears around the surface thereof after the trailing edge of the black latent image passes the developing position of the black developing unit **14**, and before a leading edge of the cyan latent image reaches the developing position of the cyan developing unit **15**, so that the cyan latent image is developed by the cyan developing unit **15**.

As in the black developing unit **14**, when a trailing edge of the cyan latent image passes the developing position of the cyan developing unit **15**, formation of the developer sleeves or ears on the cyan developing roller **15***a* is immediately stopped to disable the development by the cyan developing unit **15**. Such a stoppage of the formation of developer sleeves or ears has to be completed before a leading edge of the magenta latent image according to the magenta image data of the original document reaches the developing position of the cyan developing unit **15**.

Like the black toner image, the cyan toner image thus formed on the photoconductive drum **9** is then transferred onto the intermediate transfer belt **19** to be superimposed on the black toner image previously transferred thereto. After the transfer, the surface of the photoconductive drum **9** is cleaned by the cleaning unit **10** and is discharge by the discharge lamp **11** so that a next image forming operation can be started.

In the same manner, a magenta image and a yellow image are developed by the respective developing units **16**, **17**, and are transferred onto the intermediate transfer belt **19**. By thus transferring a toner image for each color onto the intermediate transfer belt **19** one by one in sequence superimposing one image after another, a full color image is formed on the intermediate transfer belt **19**.

Although the toner images are formed in order of black, cyan, magenta and yellow in this example, the order of formation is not limited to such and may be predetermined in any way depending upon characteristics of the toner used and/or the image quality to be obtained.

The full color toner image thus formed on the intermediate transfer belt **19** is then transferred to a transfer sheet **24** by the transfer unit **23**.

The transfer sheet **24** to which the full color toner image is transferred is conveyed to the fixing unit **28** by the conveying belt **27**. The toner image is fixed to the transfer sheet **24** between a fixing roller **28***a* heated to a predetermined temperature and a pressing roller **28***b*. The transfer sheet **24** carrying the fixed toner image is then output to a copy tray **29**, and thus a full color image is obtained.

The intermediate transfer belt **19** is spanned around the intermediate transfer bias roller **20**, a driving roller **21** and a series of supporting rollers, and is rotated in a direction indicated by an arrow in FIGS. **1** and **2** by a driving motor (not shown). Further a surface of the intermediate transfer belt **19** is cleaned by a belt cleaner **22** provided adjacent to the intermediate transfer belt **19**.

The belt cleaner **22** includes a brush roller **22***a*, a rubber blade **22***b* and a separate/contact device **22***c* as shown in FIG. **2**. The belt cleaner **22** is in contact with the intermediate transfer belt **19** before a black toner image is transferred to the intermediate transfer belt **19**. When transfer of the black toner image to the intermediate transfer belt **19** starts, the belt cleaner **22** is separated from the intermediate transfer belt **19** by the separate/contact device **22***c*.

As shown in FIG. **3**, the transfer unit **23** in this embodiment includes a transfer roller **60**, a cleaning blade **23***b* and a release agent applying device **50** for applying a release agent **51** on a surface of the transfer roller **60** so that toner and an alien substance, such as paper dust and the like, does not adhere to the surface of the transfer roller **60**. Further, as shown in FIG. **2**, a separate/contact device **23***c* for separating the transfer roller **60** from and bringing the transfer roller **60** into contact with the intermediate transfer belt **19** may be provided.

The transfer roller **60** includes a rubber layer **62** formed around a transfer roller axis **61** and a plastic coating layer **63** formed around the rubber layer **62**.

The transfer roller **60** is separated from the intermediate transfer belt **19** except when transferring a color toner image on the intermediate transfer belt **19** to a transfer sheet **24**. When transferring such an image, the transfer roller **60** is moved towards the intermediate transfer belt **19** at a predetermined timing to contact and press a transfer sheet **24** conveyed into the transfer position to the intermediate transfer belt **19**, and the toner image is transferred to the transfer sheet **24** by applying a predetermined bias voltage to the transfer roller **60**.

As shown in FIG. **1**, the transfer sheet **24** is stored, depending upon its size, in any of transfer sheet cassettes **30**, **31**, **32**, **33**, respectively accommodating a transfer sheet **24** of a particular size. If a selected size for the transfer sheet **24** is designated via an operational panel (not shown), a transfer sheet **24** of the selected size is fed out from the appropriate transfer sheet cassette accommodating the transfer sheet **24** of such a size and the transfer sheet **24** is conveyed towards the pair of registration rollers **26**. Numeral **34** in FIG. **1** denotes a manual feeding tray with which transfer sheets which are not suitable for feeding out from the transfer sheet cassettes **30**, **31**, **32**, **33**, such as, for example, a thick paper or a transparent film for use in an overhead projection device, are fed in manually.

When making multiple copies of an original document in succession with such a color copying machine, following the completion of forming the image for the fourth color, i.e. yellow, for the first copy, an image forming operation for the first color, i.e. black, for the second copy is commenced at a predetermined timing. In such a case, the black toner image for the second copy is transferred from the photoconductive drum **9** to the intermediate transfer belt **19** after the full color toner image on the intermediate transfer belt **19** is transferred to a transfer sheet **24** as the first copy and after a surface of the intermediate transfer belt **19** is cleaned by the belt cleaner **22**. The following operations for the second copy are the same as for the first copy.

The above explanation has been made for a case that an image is formed in full colors. That is, the image forming operation is performed four times, namely, one each for black, cyan, magenta and yellow, for making one full color copy, and the above-discussed operations are repeated the number of times corresponding to the designated number of copies. Likewise, in a case that an image is formed in three colors or two colors, the operation of forming the image is performed a corresponding numbers of times.

When making an image in a single color, until a designated number of copies are made, a developing unit for the designated color is kept in a condition for developing a latent image, the intermediate transfer belt **19** is kept rotating at a predetermined speed while contacting the surface of the photoconductive drum **9**, and the belt cleaner **22** is kept contacting the intermediate transfer belt **19**.

As described above, the transfer unit **23** includes the release agent applying device **50** as shown in FIG. **3**.

The release agent applying device **50** includes a solid release agent **51** disposed downstream of a position where the cleaning blade **23***b* contacts the transfer roller **60** in the rotating direction of the transfer roller **60**. The solid release agent **51** is held by a holder **52** which is movable in the direction indicated by an arrow E. The solid release agent **51** is pressed by a pressing spring **53**, which is attached to a right side surface of the solid release agent **51** in FIG. **3**, with a predetermined pressing force, so that a surface of the solid release agent **51** facing the transfer roller **60** contacts a surface of the transfer roller **60** along an entire surface in a longitudinal direction, as also shown in FIG. **4**. When the transfer roller **60** is rotating, the release agent **51** is coated on the surface of the transfer roller **60** to form a layer of the release agent **51** thereon.

In this example, as the solid release agent **51**, zinc stearate which is solidified and is formed in a bar is used as shown in FIG. **4**.

Toner and an alien substance, such as, for example, paper dust, hardly adheres to a surface of the layer of the release agent **51**. Even if toner and/or paper dust are put on the surface of the layer of the release agent **51**, such toner and/or paper dust can be easily removed therefrom. Thus, in the present invention lowering of image quality due to insufficient cleaning of the transfer roller **60** is avoided.

As described earlier, when the transfer sheet **24** contains a relatively large amount of calcium carbonate, paper dust oozed out from the transfer sheet **24** contains calcium carbonate. Such paper dust containing calcium carbonate, when adhering to a surface of the transfer roller **60**, forms a film, which is hardly scraped off by the cleaning blade **23***b*. If such a film remains on the surface of the transfer roller **60** and toner adheres to this film, it becomes harder to remove the toner adhering to this film.

As an example, in an experiment with a background image forming apparatus, after about 500 sheets of the transfer sheet **24** including a relatively large amount of calcium carbonate have passed through a transfer position between the transfer roller **60** and the intermediate transfer belt **19**, it has been observed that a surface of the transfer roller **60** becomes white with the paper dust and that the cleaning blade **23***b* can not scrape off the paper dust adhering to the surface of the transfer roller **60**.

However, in an image forming apparatus of this invention with the transfer device **23** including the above-described release agent applying device **50** in which zinc stearate is used as the release agent, it has been observed that a surface of the transfer roller **60** does not become white with paper dust, that is, adhering of paper dust including calcium carbonate is considerably reduced due to a coating of a release agent **51** on a surface of the transfer roller **60**. Further, it has been observed that even when toner adheres to the surface of the coated layer of the release agent **51**, such toner is easily removed by the cleaning blade **23***b*.

In the release agent applying device **50** configured as described above, if the coating width of the release agent **51** is made too wide, an excessive amount of the release agent **51** is coated on the surface of the transfer roller **60**. Then, when the transfer roller **60** rotates an excessive load is given to the release agent **51** due to the excessive coating of the release agent **51** on the transfer roller **60**, which may cause the release agent **51** formed in a bar to break.

Therefore, in this embodiment, as shown in FIG. **4**, a coating width W*a* of the release agent **51** is made narrower than a cleaning width W*b* of the cleaning blade **23***b*. As a result, the load given to the release agent **51** is reduced, and thereby a possibility of breaking the release agent **51** is avoided. Further, because a cleaning area of the cleaning blade **23***b* covers an entire coating area of the release agent **51**, an entire surface of the coated layer of the release agent **51** is cleaned by the cleaning blade **23***b*. Thus, toner and paper dust adhering to a surface of the coated layer of the release agent **51** is easily removed.

FIG. **5** is a schematic drawing showing a structure of another example of a transfer device according to the present invention. In FIG. **5**, corresponding parts are indicated by the same numerals as in FIG. **3**.

A transfer unit **23** in this example includes a release agent applying device **50** using the same solid release agent **51** as in the transfer unit **23** shown in FIG. **3**. In this example, an intermediate agent applying member **55** is provided between the release agent **51** and the transfer roller **60** for applying the release agent **51** on the surface of the transfer roller **60** via the intermediate agent applying member **55**. The intermediate agent applying member **51** is made of an elastic material so as not to damage a surface of the transfer roller **60**.

As the intermediate agent applying member **55**, a sponge formed in a cylinder or a fur brush roller, with substantially a same length as the release agent **51**, may be used, for example.

With such a construction, because a surface of the transfer roller **60** contacts the intermediate agent applying member **55** which is made of an elastic material and which has a coated layer of the release agent **51** around the circumferential surface, the surface of the transfer roller **60** is uniformly coated with the release agent **51**, and further, it is avoided that the surface of the transfer roller **60** is damaged.

Next, another example of a transfer device according to the present invention is explained with reference to FIGS. **6**, **7** and **8**.

FIG. **6** is a schematic drawing illustrating a structure of another example of a transfer device according to the present invention from a front view, FIG. **7** is a schematic drawing illustrating the same transfer device with an intermediate transfer belt and FIG. **8** is a schematic drawing illustrating a main part of an image forming apparatus including the transfer device shown in FIGS. **6** and **7**.

As shown in FIGS. **6** and **7**, a transfer unit **23** as the transfer device includes a transfer roller **60**, a cleaning blade **23***b*, a release agent applying device **50** including a solid release agent **51**, a bracket **61** to support the release agent **51** along a longitudinal surface of the transfer roller **60** and a plurality of plate springs **62** as a pressing device to press the bracket **61** so as to bring the release agent **51** uniformly in contact with the transfer roller **60** along an entire longitudinal surface of the transfer roller **60**, a guide plate **63** as a guide member to guide a transfer sheet **24** into a transfer area between the transfer roller **60** and an intermediate transfer belt **19** and a separate/contact device **23***c*, shown in FIG. **8**, to separate the transfer roller **60** from and to bring the transfer roller **60** in contact with the intermediate transfer belt **19**. For convenience sake, the guide plate **63** is shown as a sectional view.

The release agent applying device **50** further includes an axis **64** fixed to an upper end of the bracket **61** at each end thereof in the longitudinal direction, and the axis **64** is rotatably supported by the guide plate **63**.

FIG. **9** is a perspective exploded drawing for explaining in more detail a construction of the release agent applying device **50**.

The release agent **51** is made of zinc stearate and is formed in a solid square bar extending along the longitudinal surface of the transfer roller **60** as shown in FIG. **9**. The release agent **51** is fixed to the bracket **61** by sticking a back side of the release agent **51** to the bracket **61**.

The bracket **61** is formed in a thin plate extending in the longitudinal direction of the transfer roller **60** and the lower part of the bracket **61** is bent. The lower end of the bracket **61** is pressed uniformly by a plurality of plate springs **62** (not shown in FIG. **9**), which are arranged separated from each other at an equal spacing in the longitudinal direction of the bracket **61** and which are fixed to an under surface of the guide plate **63**, so that the release agent **51** is uniformly brought into contact with the surface of the transfer roller **60**. In this example, four plate springs **62** are provided.

It is preferable that a total pressing force by the four plate springs **62** pressing the bracket **61** is set to about 0.5 newton to about 2 newton. If the total pressing force is too weak, the release agent **51** can not be applied to the surface of the transfer roller **60**. If the total pressing force is too strong, on the other hand, friction between the release agent **51** and the transfer roller **60** increases, and there then occurs a possibility that the release agent **51** sticks to the surface of the transfer roller **60** and the release agent **51** rotates together with the bracket **61** as the transfer roller **60** rotates. By setting the total pressing force of the plate springs **62** to such a force as described above, sticking of the release agent **51** to the surface of the transfer roller **60** is prevented and the release agent **51** is properly applied to the transfer roller **60**.

Further, by thus arranging the plurality of plate springs **62** in positions equally spaced from each other along the longitudinal direction of the transfer roller **60** and setting the pressing force of each of the plurality of plate springs **62** to an equal pressing force, the release agent **51** contacts the surface of the transfer roller **60** at a substantially uniform pressing force along the longitudinal direction of the transfer roller **60**, and thereby the release agent **51** is uniformly applied to the surface of the transfer roller **60** even when the surface of the bracket **61** supporting the release agent **51** is not uniformly flat. Thus, it is thereby avoided that some part of the transfer roller **60** is not coated with the release agent **51**.

Further, the bracket **61** may include protruding pieces **61***a* at a center thereof in the longitudinal direction. In this example, as shown in FIG. **9**, the bracket **61** is provided with three protruding pieces **61***a* spaced from each other. The number of the protruding pieces **61***a* may be determined to an appropriate number. The bracket **61** integrally holds the axis **64** provided at each end of the bracket **61** by bending an upper end part of the bracket **61** in a curl form and caulking the upper end part of the bracket **61** around the axis **64**.

On the other hand, the guide plate **63** includes an axis support opening **63***a* to insert the axis **64** therein and to rotatably support the axis **64** at a rear side and a U-shaped groove **63***b* to insert therein the axis **64** therein at the other end.

Further, the release agent applying device **50** may be provided with a supporting member **66** to regulate the axis **64** inserted into the U-shaped groove **63***b* from coming off the groove **63***b* when the axis **64** is inserted into the U-shaped groove **63***b*, see also FIG. **10**. The supporting member **66** is formed with a regulating part **66***b* to regulate movement of the bracket **61** towards the transfer roller **60** around the axis **64** at each end of the bracket **61**.

Accordingly even when the release agent **51** is worn after long usage, because movement of the bracket **61** towards the transfer roller **60** is restricted by the regulating part **66***b*, the bracket **61** is prevented from directly contacting and damaging the surface of the transfer roller **60**.

The support member **66** is fixed to the guide member **63** by inserting and screwing a screw, which is inserted into a hole **66***c* formed in a side plate of the support member **66**, into a screw hole **63***c* formed in a plane of the guide member **63** where the U-shaped groove **63***b* is formed.

Thus, the image forming apparatus of this invention thrusts the release agent **51** to the surface of the transfer roller **60** by rotatably supporting the axis **64**, which is fixed at each end of the upper part of the bracket **61** supporting the release agent **51**, by the guide plate **63**, and by pressing the bracket **61** towards the transfer roller **60** by the plurality of plate springs **62**.

Therefore, if the transfer roller **60** rotates, the release agent **51** is uniformly applied to the surface of the transfer roller **60** to form a layer of the release agent **51** thereupon. Toner and an alien substance, such as, for example, paper dust, thereby hardly adheres to a surface of the coated layer of the release agent **51**, and further, even when toner and/or paper dust are put on the surface of the coated layer of the release agent **51**, such toner and/or paper dust can be easily removed. Thus, lowering of image quality due to insufficient cleaning of the transfer roller **60** is avoided.

Further, because the release agent applying device **50** is constructed in an integrated assembly, such that the release agent **51** is integrally supported by the bracket **61** and the bracket **61** is integrally and rotatably supported by the guide plate **63**, the release agent applying device **50** can be easily mounted to the transfer unit **23** at a predetermined position.

Further, the guide member **63** includes, at a plane facing the bracket **61**, a stopping member **67** to regulate bending of the bracket **61** towards a direction to separate from the transfer roller **60** at a center part of the bracket **61** by bringing the protruding pieces **61***a* into contact with the stopping member **67**. Therefore, even when a thin plate is used for the bracket **61** for reducing cost and an axis is not provided in the center part of the bracket **61**, and thereby the center part of the bracket **61** in the longitudinal direction is bent, the stopping member **67** regulates the bending of the bracket **61**, such that the release agent **51** stably contacts the surface of the transfer roller **60**.

Further, because the bracket **61** is mounted to the guide plate **63** by inserting the axis **64** at a rear side into the axis support hole **63***a*, inserting the axis **64** at a front side into the U-shaped groove **63***b* from below and supporting the axis **64** by the supporting member **66** from below, the bracket **61** can be easily mounted to the guide plate **63**.

The release agent **51** and the transfer roller **60** wear after long usage and need to be replaced when they are worn. When either of the release agent **51** and the transfer roller **60** is replaced, before starting an image forming operation, it is necessary to apply the release agent **51** to the surface of the transfer roller **60** until a uniform layer of the release agent **51** is formed on the surface of the transfer roller **60**, in other words, until the apparatus is brought into a state ready to start an image forming operation again.

Generally, a certain number of copies are made by a service person to bring the image forming apparatus to a state ready to start image forming again, which results in wasting transfer sheets and time.

Therefore, in the image forming apparatus of this invention, as shown in FIG. **11**, a controller **72** is provided to rotate only the transfer roller **60** a prescribed number of times while stopping an image forming operation including

feeding of a transfer sheet **24**. Further, a mode select key **71** is provided in an operational panel of the apparatus as a device for selecting a mode to stop the image forming operation and to rotate the transfer roller **60** alone for the prescribed number of times. The controller **72** may be conveniently implemented using a conventional microprocessor programmed according to the teachings of the present specification, as will be apparent to those skilled in the computer art.

Accordingly, when the transfer roller **60** or the release agent **51** is replaced, by selecting such a mode via the mode select key **71**, the release agent **51** can be applied on the surface of the transfer roller **60** until a same uniform layer of the release agent **51** as before the replacement is formed on the surface of the transfer roller **60** without continuously forming images and wasting a large number of transfer sheets **24**.

It is preferable that a number of times or a period of time to rotate the transfer roller **60** can be set arbitrarily to the controller **72** via a control panel, such that a service person can set an optimum number of times or an optimum period of time to rotate the transfer roller **60** in accordance with conditions of the release agent **51** or conditions of the transfer roller **60**. For example, when the above-mentioned mode is selected via the mode select key **71**, a display (not shown) in the operational panel displays a message requesting to input a desired number of times or a desired period of time to rotate the transfer roller **60**. Then, the service person can input the desired number of times or the period of time via a ten key (not shown) in the operational panel. Thus, wasting of the release agent **51** and time are avoided.

Obviously, numerous additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

The present application is based on Japanese Priority Documents 08-189533 and 08-193564, the contents of which are incorporated herein by reference.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An image forming apparatus including an image carrier and a transfer device to transfer an image on the image carrier to a transfer sheet, the transfer device having a transfer roller and transferring an image on the image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device further comprising a release agent applying device to apply a release agent to a surface of the transfer roller.

2. The image forming apparatus according to claim **1**, wherein the release agent is zinc stearate.

3. The image forming apparatus according to either one of claims **1** or **2**, wherein the transfer device further comprises a cleaning member to clean the surface of the transfer roller.

4. An image forming apparatus including an image carrier and a transfer device to transfer an image on the image carrier to a transfer sheet, the transfer device having a transfer roller and transferring an image on the image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device further comprising a release agent applying device to apply a release agent to a surface of the transfer roller, wherein the transfer device further comprises a cleaning member to clean the surface of the transfer roller, and wherein a width of the release agent applied by the release agent applying device is narrower than a width the cleaning member cleans.

5. An image forming apparatus including an image carrier and a transfer device to transfer an image on the image carrier to a transfer sheet, the transfer device having a transfer roller and transferring an image on the image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device further comprising a release agent applying device to apply a release agent to a surface of the transfer roller, and wherein the release agent applying device applies the release agent to the surface of the transfer roller at all times when the transfer roller is rotating.

6. An image forming apparatus including an image carrier and a transfer device to transfer an image on the image carrier to a transfer sheet, the transfer device having a transfer roller and transferring an image on the image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device further comprising a release agent applying device to apply a release agent to a surface of the transfer roller, and wherein the release agent is solidified and contacts the surface of the transfer roller.

7. The image forming apparatus according to claim **6**, wherein the transfer device further includes a guide member to guide a transfer sheet to an area between the transfer roller and the image carrier, the release agent applying device includes a bracket to hold the release agent along a longitudinal surface of the transfer roller and a pressing member to press the bracket so that the release agent contacts the longitudinal surface of the transfer roller, and the bracket being rotatably supported by the guide member.

8. The image forming apparatus according to claim **7**, wherein the pressing member includes a plurality of pressing elements, being equally spaced from each other along the longitudinal direction of the transfer roller, and each of the plurality of the pressing elements presses the bracket with an equal pressing force.

9. The image forming apparatus according to claim **8**, wherein a total pressing force pressing the bracket is between about 0.5 newton to about 2 newton.

10. The image forming apparatus according to claim **7**, wherein the bracket includes at least one protruding piece at a center thereof in a longitudinal direction of the transfer roller and the guide member includes, at a plane facing the bracket, a stopping member to regulate bending of the bracket by bringing the at least one protruding piece into contact with the stopping member.

11. The image forming apparatus according to claim **7**, wherein the bracket has an axis at each end, each axis protruding from the bracket, the guide member being formed with an opening for inserting the axis therein to support the axis protruding from a first side of the bracket and a U-shaped groove for inserting the axis thereto to support the axis protruding from a second side of the bracket, the transfer device further including a supporting member to prevent the axis inserted into the U-shaped groove from coming off the U-shaped groove when the axis is inserted into the U-shape groove, and the supporting member being formed with a regulating part to regulate rotational movement of the bracket towards the transfer roller around the axis at each end of the bracket.

12. An image forming apparatus including an image carrier and a transfer device to transfer an image on the image carrier to a transfer sheet, the transfer device having a transfer roller and transferring an image on the image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device further comprising a

release agent applying device to apply a release agent to a surface of the transfer roller, and wherein the transfer device further includes an elastic intermediate agent applying member between the transfer roller and the release agent applying device so that the release agent is applied to the surface of the transfer roller via the elastic intermediate agent applying member.

13. An image forming apparatus including an image carrier and a transfer device to transfer an image on the image carrier to a transfer sheet, the transfer device having a transfer roller and transferring an image on the image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device further comprising a release agent applying device to apply a release agent to a surface of the transfer roller, and means for stopping an image forming operation while rotating the transfer roller.

14. The image forming apparatus according to claim **13**, further comprising means for selecting a mode to stop an image forming operation while rotating the transfer roller.

15. An image transfer device for an image forming apparatus, including a transfer roller for transferring an image on an image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device comprising a device to apply a release agent to a surface of the transfer roller.

16. The image transfer device according to claim **15**, wherein the release agent is zinc stearate.

17. The image transfer device according to either one of claims **15** or **16**, wherein the transfer device further comprises a cleaning member to clean the surface of the transfer roller.

18. An image transfer device for an image forming apparatus, including a transfer roller for transferring an image on an image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device comprising a device to apply a release agent to a surface of the transfer roller, wherein the transfer device further comprises a cleaning member to clean the surface of the transfer roller, and wherein a width of the release agent applied by the release agent applying device is narrower than a width the cleaning member cleans.

19. An image transfer device for an image forming apparatus, including a transfer roller for transferring an image on an image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device comprising a device to apply a release agent to a surface of the transfer roller, wherein the release agent applying device applies the release agent to the surface of the transfer roller at all times when the transfer roller is rotating.

20. An image transfer device for an image forming apparatus, including a transfer roller for transferring an image on an image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device comprising a device to apply a release agent to a surface of the transfer roller, wherein the release agent is solidified and contacts the surface of the transfer roller.

21. The image transfer device according to claim **20**, the transfer device further includes a guide member to guide a transfer sheet to an area between the transfer roller and the image carrier, the release agent applying device includes a bracket to hold the release agent along a longitudinal surface of the transfer roller and a pressing member to press the bracket so that the release agent contacts the longitudinal surface of the transfer roller, and the bracket being rotatably supported by the guide member.

22. The image transfer device according to claim **21**, wherein the pressing member includes a plurality of pressing elements, being equally spaced from each other along the longitudinal direction of the transfer roller, and each of the plurality of the pressing elements presses the bracket with an equal pressing force.

23. The image transfer device according to claim **22**, wherein a total pressing force pressing the bracket is between about 0.5 newton to about 2 newton.

24. The image transfer device according to claim **21**, wherein the bracket includes at least one protruding piece at a center thereof in a longitudinal direction of the transfer roller and the guide member includes at a plane facing the bracket, a stopping member to regulate bending of the bracket by bringing the at least one protruding piece into contact with the stopping member.

25. The image transfer device according to claim **21**, wherein the bracket has an axis at each end, each axis protruding from the bracket, the guide member being formed with an opening for inserting the axis therein to support the axis protruding from a first side of the bracket and a U-shaped groove for inserting the axis thereto to support the axis protruding from a second side of the bracket, the transfer device further including a supporting member to prevent the axis inserted into the U-shaped groove from coming off the U-shaped groove when the axis is inserted into the U-shape groove, and the supporting member being formed with a regulating part to regulate rotational movement of the bracket towards the transfer roller around the axis at each end of the bracket.

26. An image transfer device for an image forming apparatus, including a transfer roller for transferring an image on an image carrier to a transfer sheet conveyed between the transfer roller and the image carrier by applying a bias voltage to the transfer roller, the transfer device comprising a device to apply a release agent to a surface of the transfer roller, wherein the transfer device further includes an elastic intermediate agent applying member between the transfer roller and the release agent applying device so that the release agent is applied to the surface of the transfer roller via the intermediate agent applying member.

27. The image forming apparatus according to any one of claims **4–14** or **18–26**, wherein the release agent is zinc stearate.

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